SOYBEAN DISEASES

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SOYBEAN DISEASES

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In cooperation with the agricultural experiment stations of Mississippi, Illinois, and North Carolina.

Approximately 50 diseases attack soybeans in the United States. Damage to the crop in any area in a given year may be slight or severe, depending on the diseases present and whether conditions are favorable for their spread.

Even in fields that appear reasonably free of diseases, losses may be considerable because of unnoticed damage by a succession of parasites throughout the growing season. Estimates for the entire country covering the 10-year period, 1942–51, indicate that annual losses amount to more than 31 million bushels of soybeans, or approximately 12½ percent of the crop.

Soybean diseases are caused by parasitic bacteria, fungi, viruses, and nematodes. To reduce losses, the grower needs to be able to identify the diseases and apply the most effective control measures available against them. This bulletin describes the symptoms of the more important soybean diseases and discusses control measures that can be used.

BACTERIAL DISEASES

Three bacterial diseases attack soybeans in the United States. These have the common names bacterial blight, bacterial pustule, and wildfire.

BACTERIAL BLIGHT

Bacterial blight is one of the most widespread diseases of soybeans. It is most common and conspicuous on the leaves but can also affect the stems and pods. The first symptoms on the leaves are small, angular, yellow spots. These frequently appear water-soaked at the center and are surrounded by a narrow, yellowish-green halo. Later the spots become brown to black as the leaf tissues die. Many small spots may join, thus causing large, dead areas on the leaves. Diseased leaves become badly shredded during periods of wind and rain.

The disease is most serious during periods of cool weather and frequent rains. Severe infection causes premature defoliation.

The bacteria causing blight are seedborne and can survive also in diseased leaves from one growing season to the next. Crop rotation and complete coverage of residues by plowing after fall harvest aid in holding the disease in check. Flambeau and Hawkeye are less susceptible than most northern varieties but are not immune. Southern varieties are susceptible, but blight usually is not as serious in the South as it is farther north.

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BACTERIAL PUSTULE

Bacterial pustule occurs to some extent in almost every soybean field. In the Northern States its prevalence and severity seem to vary considerably from year to year, depending on conditions in each growing season, but in the South it is more uniformly severe.

Like blight, pustule is most common on the leaves but it can affect the pods. The first symptoms on the leaves are small, yellowish-green spots with reddish-brown centers. These are more conspicuous on the upper surface of the leaf (fig. 1). Small, raised pustules soon develop at the center of the spots, especially in the lower leaf surface. The presence of pustules and the absence of a water-soaked appearance serve to distinguish bacterial pustule from blight, although the symptoms of the two diseases are much alike. During late stages of the disease, many small spots join, forming large, irregular, brown areas, parts of which drop out, giving the leaf a ragged appearance.

The bacteria causing pustule are seedborne and can overwinter in diseased leaves. Crop rotation and complete coverage of the crop residues, as recommended for bacterial blight, will aid in reducing the severity of pustule. The commercial varieties of soybeans grown in the North are all susceptible to bacterial pustule. Ogden, a variety that is widely grown in the South, is moderately resistant. Lee, a variety recently released for growth in the South, combines resistance to bacterial pustule and desirable agronomic characteristics.

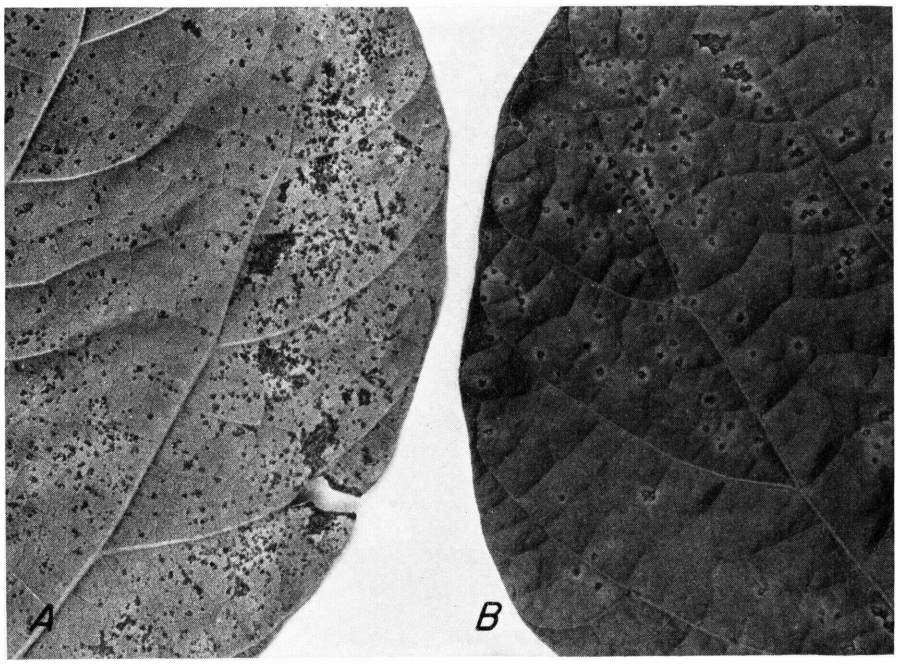

FIGURE 1.—Bacterial pustule (*A*) on the lower surface of a soybean leaflet, and (*B*) on the upper surface.

WILDFIRE

Wildfire is more limited in its distribution than bacterial pustule or bacterial blight. In general, this disease

is more serious in the Southern States than in the Midwest. It is primarily a leaf disease, causing brown to black dead spots from 1/8 to 1/2 inch or more in diameter. Sometimes the spots enlarge and join, forming large, dead areas on the leaf. Whatever their size, the spots are surrounded by a broad yellow halo (fig. 2). These broad halos aid in differentiating wildfire from the other bacterial diseases of soybeans. Severe wildfire infection causes considerable loss of leaves.

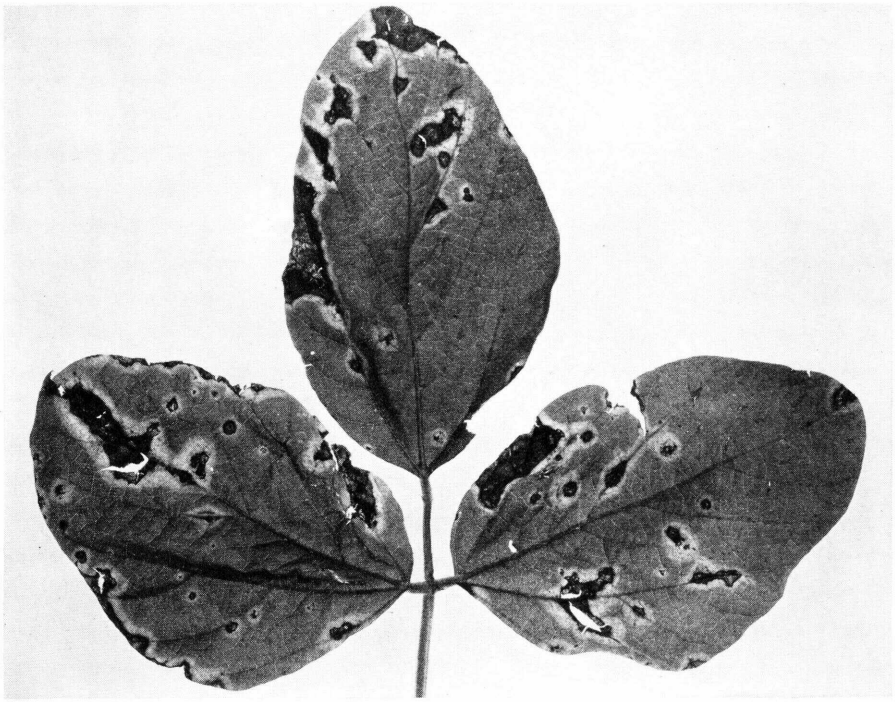

FIGURE 2.—Wildfire on a soybean leaf, showing dark spots of dead tissue surrounded by broad halos.

Wildfire infects most readily when the leaves are first infected with bacterial pustule. There is some evidence that bacterial blight also encourages infection by wildfire.

The bacteria causing wildfire are seedborne. They may live also for 3 or 4 months in infected leaves on the ground. In buried leaves, they are shorter lived. Crop rotation and thorough plowing under of the crop residues aid in control. Ogden and Lee remain relatively free of wildfire.

FUNGUS DISEASES

Many fungus diseases attack soybeans in the United States. Only the more important ones are discussed in this bulletin. These include brown stem rot, stem canker, pod and stem blight, frogeye, brown spot, target spot, downy mildew, purple seed stain, sclerotial blight, and rhizoctonia disease.

BROWN STEM ROT

Brown stem rot is caused by a soil-inhabiting fungus that enters the soybean plant through the roots and lower stem. When infected stems are split open, a brown discoloration can be seen (fig. 3).

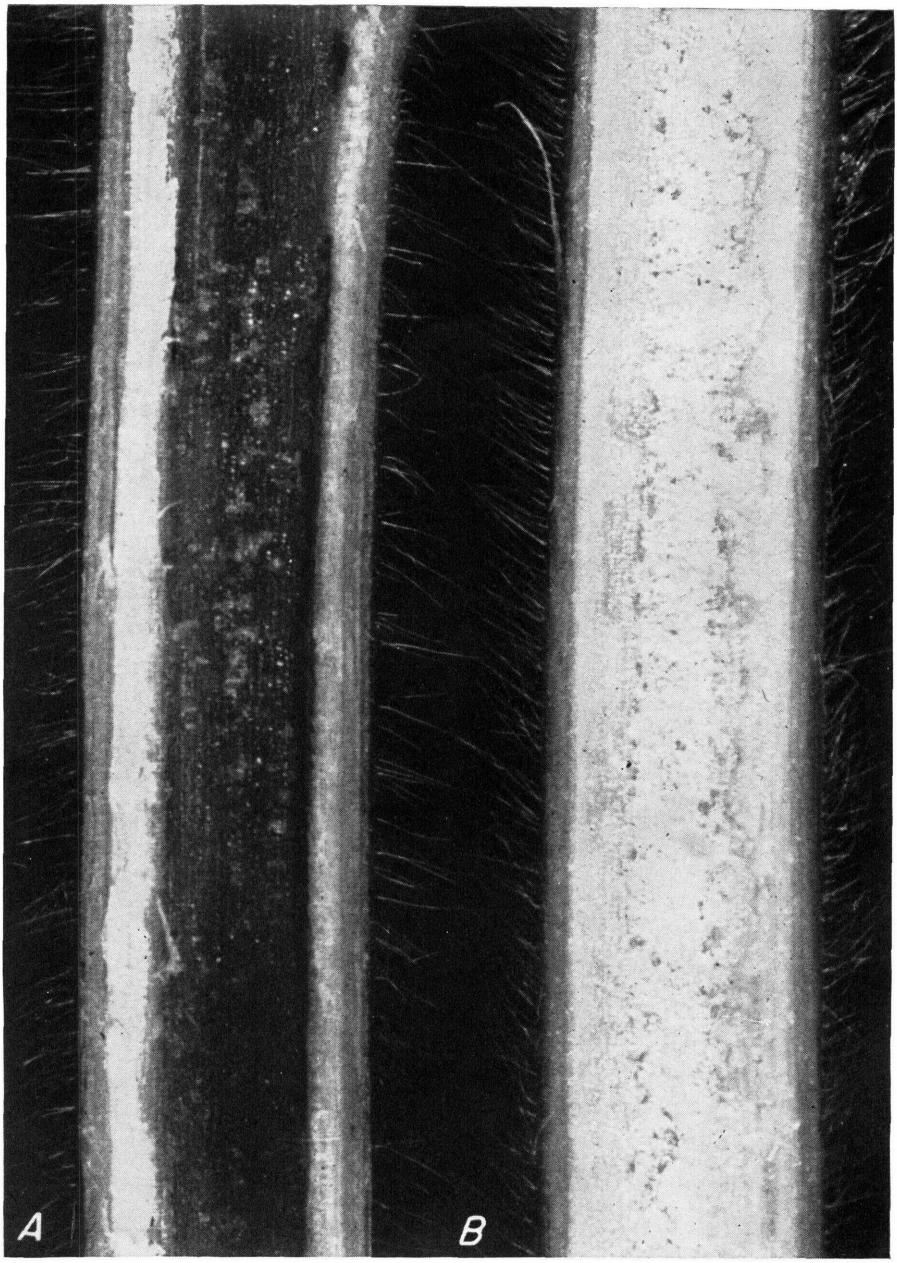

FIGURE 3.—Soybean stems split open to show (*A*) the dark-brown internal discoloration characteristic of brown stem rot, and (*B*) the white interior of a normal stem.

Leaf symptoms do not always occur, but when they do the leaves on diseased plants dry rapidly, usually in late August or early September. Leaf tissues between the veins turn brown, while those near the veins remain green. Within a few days, however, the entire leaf has withered and a badly

infected field turns brown in contrast to the yellowish-green color of a normally maturing field. Severely attacked plants lodge and produce seed that is smaller than normal.

Brown stem rot was first discovered in central Illinois in 1944. The disease seems to be confined principally to the North Central States and southern Canada.

There are no resistant varieties. The only control measure known at present is a rotation in which soybeans are grown in a field only once in 3 or 4 years.

STEM CANKER

Stem canker is caused by a fungus that enters the main plant stem at the base of a lateral branch or leaf. A brown, sunken area develops and girdles the stem, thus stopping the movement of nutrients. As a result, the plant is killed and the leaves dry up. They remain attached to the plant, however, instead of falling off as they normally would at maturity. The disease usually appears after mid-July. It is most common in the Midwest, especially in Indiana, Illinois, and Iowa.

The fungus is seedborne. It lives over also in diseased stems left in the field during the winter. The spores produced on such residues serve to spread the disease during the following season. Crop rotation, complete plowing under of the crop residues, and the use of disease-free seed are recommended as control measures.

No highly resistant varieties are known. However, field observations indicate that the variety Harosoy is more resistant than other varieties commonly grown.

POD AND STEM BLIGHT

Pod and stem blight is quite similar to stem canker in some of its symptoms. The fungi causing these two diseases are closely related also. Pod and stem blight, however, differs in that it attacks plants late in the season when they are near maturity and produces an abundance of small, black pimples on the stems and pods. On the stems, these are often arranged in straight vertical rows. Pod and stem blight is much more widespread than stem canker and occurs in all of the soybean-growing areas of the United States.

The fungus causing pod and stem blight is seedborne and also overwinters on diseased stems left in the field. The control measures recommended for stem canker are applicable. No resistant varieties are known.

FROGEYE

Frogeye is primarily a disease of the soybean leaves. When the fungus grows into the leaf tissue, it causes an eye-spot lesion composed of a gray or tan central area and a narrow, reddish-brown border (fig. 4). Heavily spotted leaves usually fall prematurely. Infection can also occur on stems and pods late in the growing season. The fungus sometimes grows through the pod wall and enters the seed.

Overwintering of the frogeye fungus is possible in infested seed and on debris left in the field from a diseased crop. The fungus may be introduced into new fields and communities through the planting of infested seed. For this reason, seed for planting should not be saved from a field severely infested with frogeye, nor should a field which grew a crop badly diseased with frogeye be replanted to soybeans until 2 or 3 years have elapsed. Thorough plowing under of the residues from a diseased crop will aid in holding this disease in check.

Although frogeye has been considered primarily a disease of the southern producing areas, it was prevalent in the lower half of Indiana up to 1950. At that time, the resistant varieties Lincoln and Wabash replaced the susceptible varieties Gibson and Patoka. In the Midwest, the varieties Adams, Lincoln, Wabash, and Clark are resist-

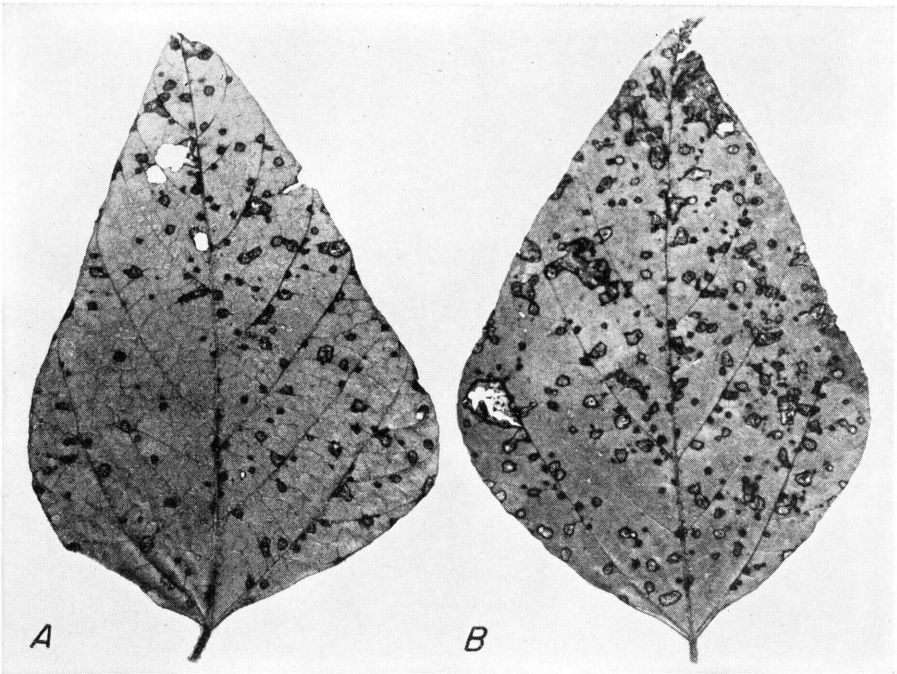

FIGURE 4.—Frogeye (*A*) on the lower surface of a soybean leaflet, and (*B*) on the upper surface.

ant to frogeye; Perry and Chief are moderately resistant. In the Southern States, the varieties Jackson, Lee, Roanoke, Dorman, and Ogden are resistant. The hay varieties, such as Tanner and Laredo, are very susceptible to frogeye infections.

BROWN SPOT

Brown spot, formerly regarded as a disease of minor importance, has increased in prevalence and severity in the Midwest in recent years. The disease appears early in the growing season on the primary leaves of young plants as angular, reddish-brown spots that vary from the size of pinpoints to one-fifth inch in width. As the plants grow, the fungus spores produced on the primary leaves spread and infect the trifoliate leaves, stems, and pods. Heavily infected leaves gradually turn yellow and fall prematurely, defoliation proceeding from the base toward the top of the plant. In badly diseased fields, the lower half of the plant stems may be bare of leaves before maturity.

Sometimes the fungus grows through the pod wall and into the seed. Therefore, seed from badly diseased fields should not be saved for planting. The causal fungus also overwinters on diseased leaves and stems left in the field. Crop rotation and thorough turning under of the crop residues render much of this overwintering material harmless. None of the commercially grown varieties of soybeans are resistant to brown spot.

TARGET SPOT

Target spot, like frogeye, is primarily a disease of the soybean leaves, but it also occurs on the stems and pods. Sometimes, the fungus penetrates the pod wall and forms small, dark spots on the seed. Spots on infected leaves are reddish brown, circular to irregular in shape, and vary from pinpoint size to one-half inch or more

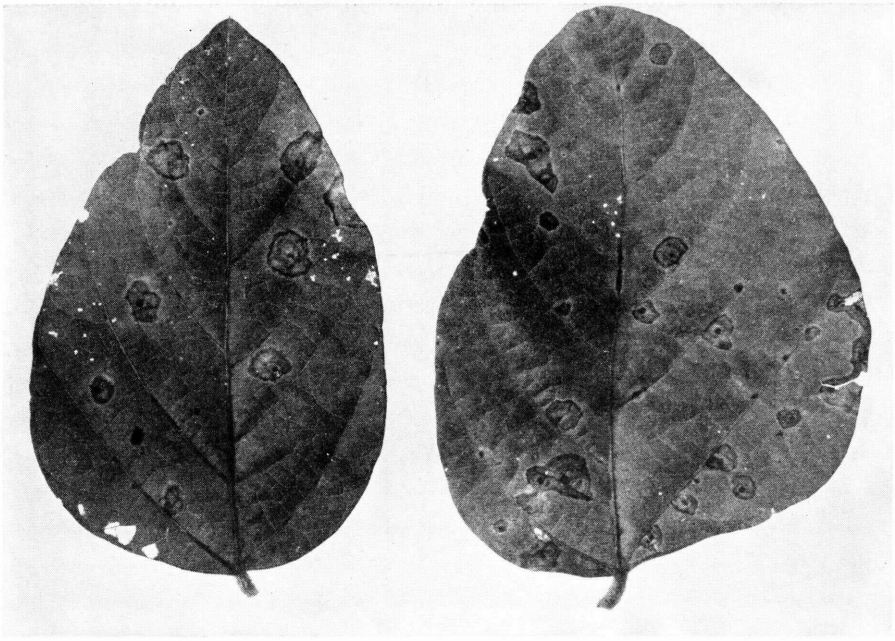

FIGURE 5.—Target spot on two soybean leaflets, showing zonation within the spots and narrow chlorotic band around them.

in diameter. The larger spots are concentrically ringed and the common name "target spot" was suggested by this characteristic (fig. 5). The causal fungus overwinters on debris left in the field from a previously diseased crop and may be spread into new fields and communities through the planting of infested seed.

The disease is most prevalent in the lower Mississippi Valley but occurs also in the other southern producing areas. It has not been reported from the Midwest.

Crop rotation and careful plowing under of the crop residues in the fall will help in controlling target spot. Ogden, the variety most commonly grown in the Southern States, possesses moderate resistance. Jackson and Lee, varieties recently released for growth in the South, are also resistant.

DOWNY MILDEW

Downy mildew of soybeans is characterized in its early stages by yellowish-green areas on the upper surface of the leaves. As the disease progresses, these become light- to dark-brown spots with yellowish-green margins. A grayish, moldlike growth develops on the under surface of the spots from which spores are produced that spread the disease from plant to plant. Severely diseased leaves fall prematurely.

In addition to the externally borne summer spores, thick-walled resting spores develop within the leaf tissues. These overwinter in the fallen diseased leaves and provide inoculum for infecting the next season's crop. The fungus also grows within the pods and covers some of the seeds with a white crust composed principally of thick-walled resting spores (fig. 6). Some of the seedlings that develop from such encrusted seeds have the fungus growing within them. The first leaves to unfold on such seedlings are soon covered with the summer spores of the fungus and thus provide centers of infection in the new season's crop.

Downy mildew occurs in all the soybean-growing areas of the United

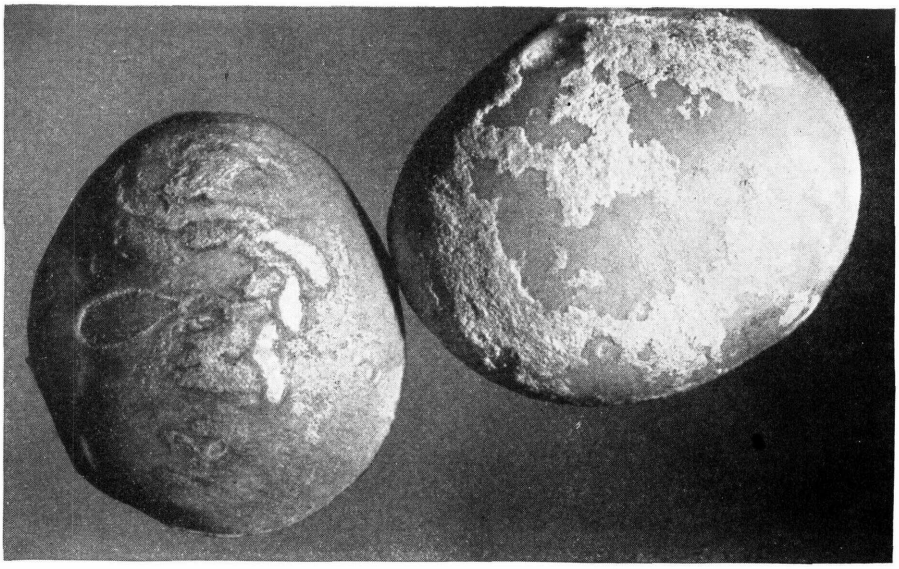

FIGURE 6.—Soybean seeds encrusted with downy mildew resting spores.

States and in some years is one of the most prevalent diseases. However, severe losses from the disease have not been reported.

Complete coverage of the residues from a diseased crop will destroy much of the overwintering inoculum in the fallen leaves. Should a field become severely diseased with downy mildew, the seed harvested should not be saved for planting. Of the commercially grown varieties, Chief and Dunfield in the Midwest and Acadian and Dorman in the South appear to be resistant to downy mildew.

PURPLE SEED STAIN

Purple seed stain is caused by a fungus that grows in the soybean seed coats and produces a light- to dark-purple discoloration. The size of the discoloration may vary from a small spot on the seed to the entire surface of the seed coat (fig. 7). Cracks occur in the discolored seed coats, giving the seed a rough, dull appearance.

When infected seeds are planted, the fungus grows from the seed coat into some of the young seedlings. Such diseased seedlings are the primary source of spores which infect leaves, stems, and pods later in the season. Seed infection and discoloration follow. Wet weather during the latter part of the growing season favors the development of purple-stained seeds. Under such conditions, 50 percent or more of the seeds of susceptible varieties may be discolored.

The purple seed stain disease occurs in all the soybean-producing areas of the United States. Infected seeds germinate almost as well as normal seeds and the infection has little or no effect on oil content. However, the discoloration is objectionable to the producer of pure seed. In a few cases, badly discolored seed lots have been classed as mixed beans at the soybean elevators.

The fungus probably survives the winter in diseased leaves and stems, as well as in the infected seed. Crop rotation and complete plowing under of the crop residues will aid in holding the disease in check. Treating purple-stained soybean seed with a disinfectant, such as Arasan or Spergon, will largely prevent seedling losses, but will not assure freedom from purple stain in the harvested crop. The varieties

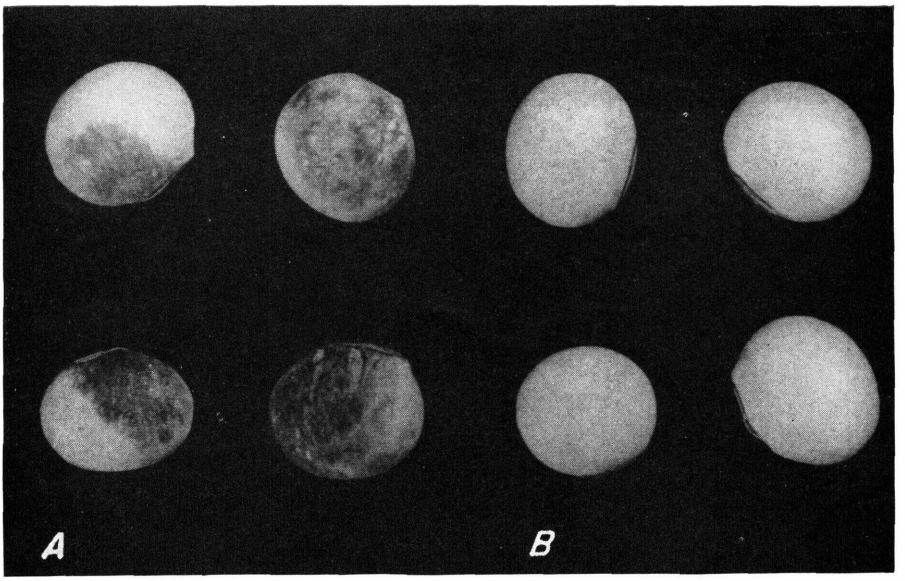

FIGURE 7.—Soybean seeds showing (*A*) purple stain, and (*B*) normal condition.

Jackson, Lee, and Roanoke are moderately resistant to purple seed stain.

SCLEROTIAL BLIGHT

Sclerotial blight is a disease of the roots and basal stem of the soybean plant. The causal fungus produces a cottony growth on the stem base and sometimes on the ground around the stem. On this growth hard, round, dark-brown bodies are formed that resemble mustard seeds. These are the resting bodies (sclerotia) of the fungus that live over in the soil and thus enable the parasite to persist from one season to the next. Diseased plants die prematurely, frequently before the seed has developed.

This disease is found principally in the sandy soil areas of the South, where high summer temperatures occur. The common name "southern blight" is sometimes applied to it. The fungus attacks a wide variety of plants, including practically all of the summer legumes adapted to the South. In some soybean fields, losses may be as high as 25 to 30 percent of the plants.

Deep plowing under of the crop residues will aid in controlling sclerotial blight. There are no resistant varieties.

RHIZOCTONIA DISEASE

Rhizoctonia disease is caused by a widespread, soil-inhabiting fungus. It occurs as damping-off, root rot, and basal stem rot in a number of crops. The disease is usually of minor importance on soybeans, but in wet growing seasons may cause up to 10 percent loss in stand in some North Central States.

Infections occur early in the season. Young soybean plants are attacked and a reddish-brown decay of the outer layer of the main root and basal stem is caused. Frequently, much of the secondary root system is destroyed also (fig. 8). Attacked plants wilt and die. Dead plants occur typically in areas 4 to 10 feet in diameter, usually distributed at irregular intervals over a field.

Seed treatment has shown some promise of controlling the damping-off and root rot stages of rhizoctonia disease, especially when the fungicide is

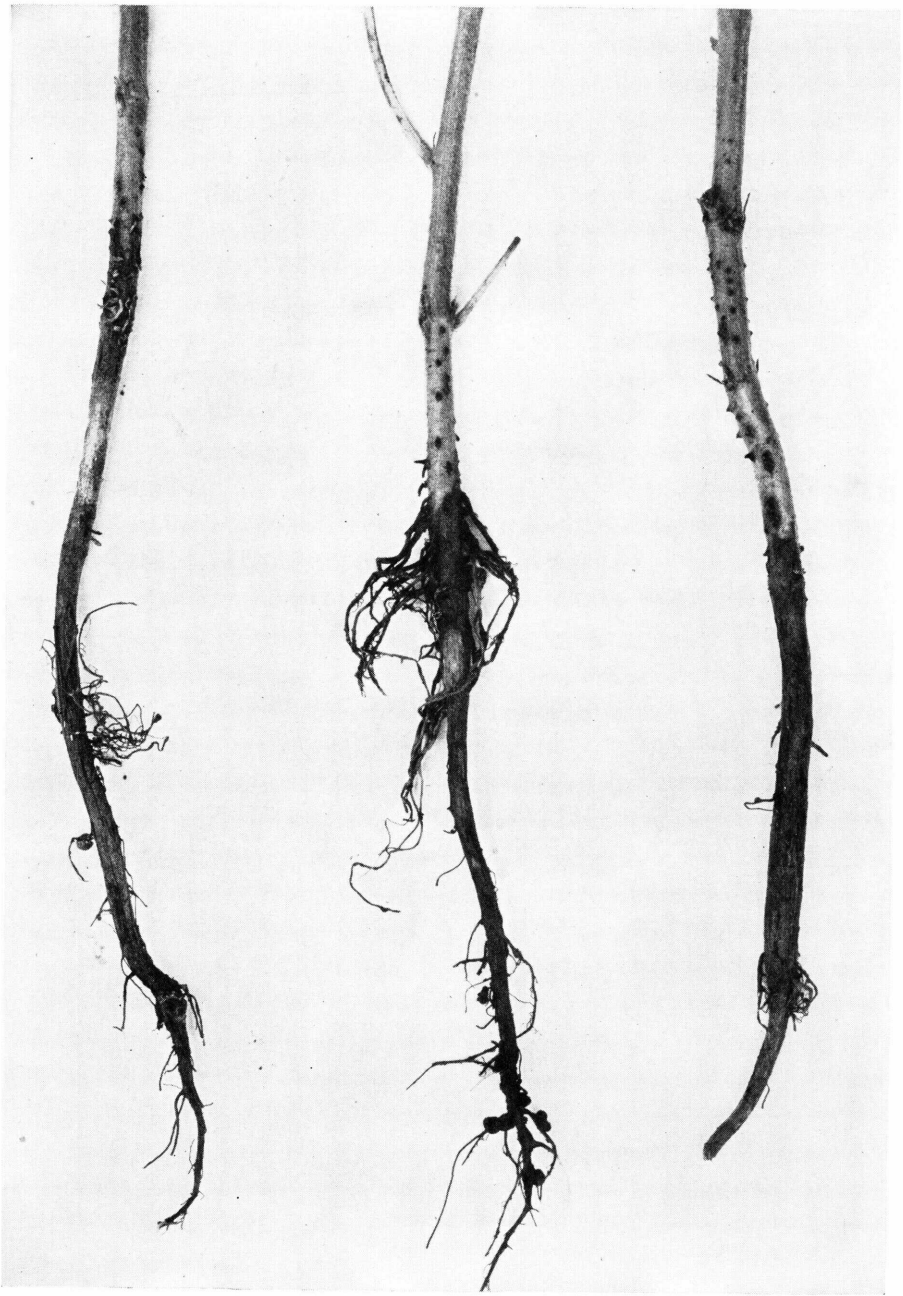

FIGURE 8.—Rhizoctonia root and basal stem rot of young soybean plants.

pelleted on the seed. None of the commercially grown varieties are resistant.

In the South, rhizoctonia disease sometimes occurs on the aerial parts of the soybean plants and causes a spotting or blighting of the leaves. The spots are irregular in shape and buff to brown in color. This phase of the

disease has been observed on soybeans in North Carolina and Louisiana. It develops best under hot, humid conditions.

VIRUS DISEASES

Three virus diseases attack soybeans in the United States. These have the common names mosaic, yellow mosaic, and bud blight.

MOSAIC

Soybean mosaic occurs to a limited extent in all the soybean-producing areas of the United States. Plants infected with the virus can be recognized readily since they are stunted and have distorted leaves. The leaves are narrower than normal and are deeper green. The margins are turned down and the blades are severely ruffled along the edge of the main veins (fig. 9). Virus-infected plants produce distorted pods and fewer seed than normal plants.

With the onset of high summer temperatures, the leaf distortion tends to disappear in soybean varieties grown for oil. Some of the vegetable varieties, however, continue to develop distorted leaves regardless of temperature.

The virus is seedborne and some of the seeds from disased plants produce virus-infected plants if sown the following season. Planting seed should not be saved, therefore, from a field severely infested with mosaic. No resistant varieties are known.

YELLOW MOSIAC

Soybean plants infected with yellow mosaic virus are not noticeably stunted and the leaves are not distorted as in common mosaic. The younger leaves show a scattered, yellow mottling, or sometimes an indefinite yellow band along the major vein. Rusty, dead spots develop in the yellowed areas as the leaves mature.

There is no evidence that the virus is seedborne and its effect on yield is not serious. The disease is widely distributed in the Midwest, but infection thus far has not been known to exceed 1 percent in any field. Apparently, it is not common in the South. No resistant varieties are known.

BUD BLIGHT

Bud blight occurs throughout the soybean areas of the Midwestern States and in southern Canada. It occurs rarely in the southern United States. Severe losses occurred in some midwestern fields between 1943 and 1947, but for some unknown reason, the disease has decreased considerably in severity and prevalence since then.

The symptoms of bud blight vary with the stage of development at which plants become infected with the virus. When young plants are infected before flowering, the tip bud turns brown, curves downward markedly, and becomes dry and brittle. The leaf just below the tip bud often develops a rusty flecking. The plant is dwarfed and produces no seed. Sometimes, the inside of the stem below the blighted terminal bud is discolored, especially at the nodes. Plants infected at flowering time produce small, undeveloped pods. Infection after flowering results in poorly filled pods that have a conspicuous purple blotching. Many such pods drop to the ground. Infected plants usually remain green after normal plants have matured, and thus are found most easily in the fall.

The disease usually appears first at the border of a field and progresses inward. This suggests an insect carrier of the virus, but such an insect has not yet been found. There is some recent evidence that the bud blight virus is seedborne. There is no known resistance to bud blight in any soybean variety and no effective control.

ROOT KNOT

Soybeans are attacked by several different kinds of nematodes (microscopic eelworms). The most common of

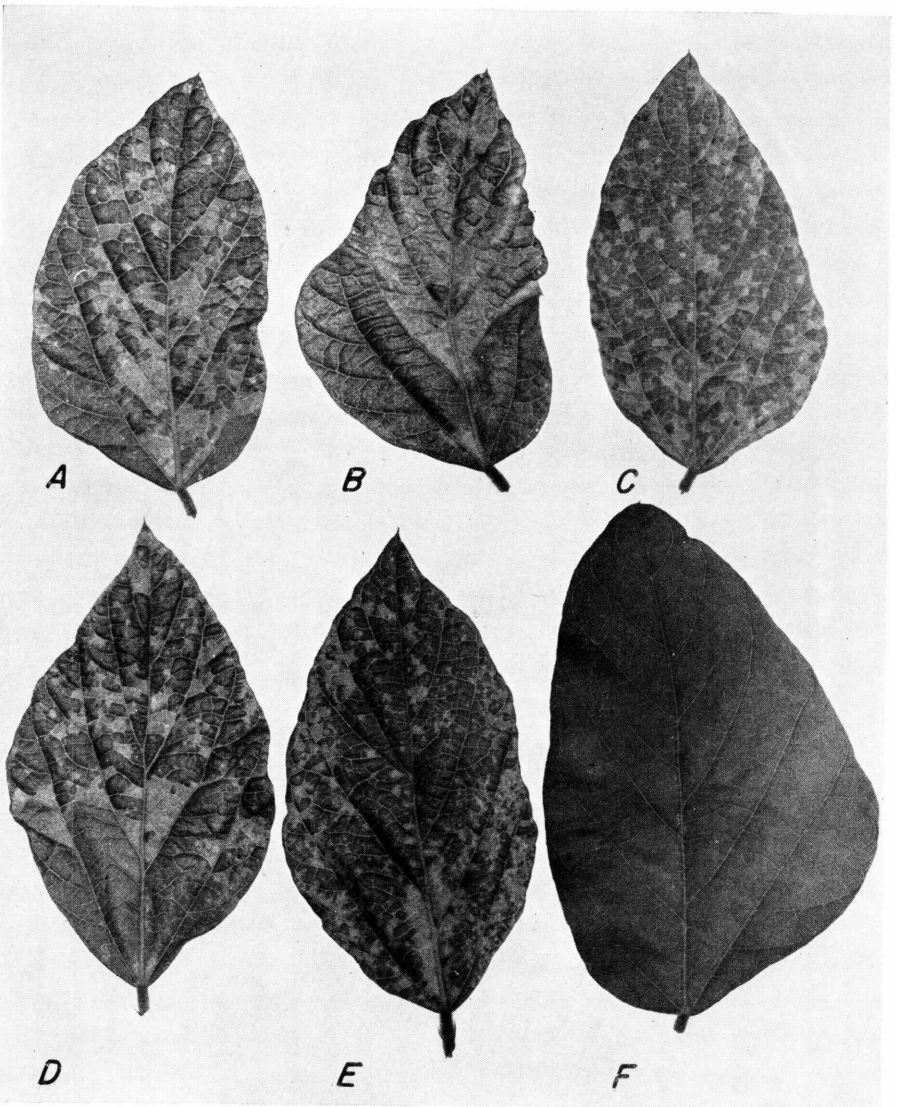

FIGURE 9.—Soybean leaflets showing (*A* to *E*) the distorted growth caused by mosaic virus, and (*F*) smooth-bladed normal growth.

these cause knotlike swellings, or galls, on the roots. This abnormal condition is called root knot.

The tiny root-knot nematodes enter young soybean roots and feed there, stimulating the root cells to greatly increased growth, thus forming the characteristic swelling or galls. The female nematodes produce a large number of eggs from which new eelworms develop. These migrate to new positions, either enlarging the galls already present or forming new ones. In roots growing in warm soil, this process is repeated every 30 or 40 days, and may cause severe malformations of the roots.

The galls are roughly spherical in shape. They vary greatly in size, some being barely visible swellings of the

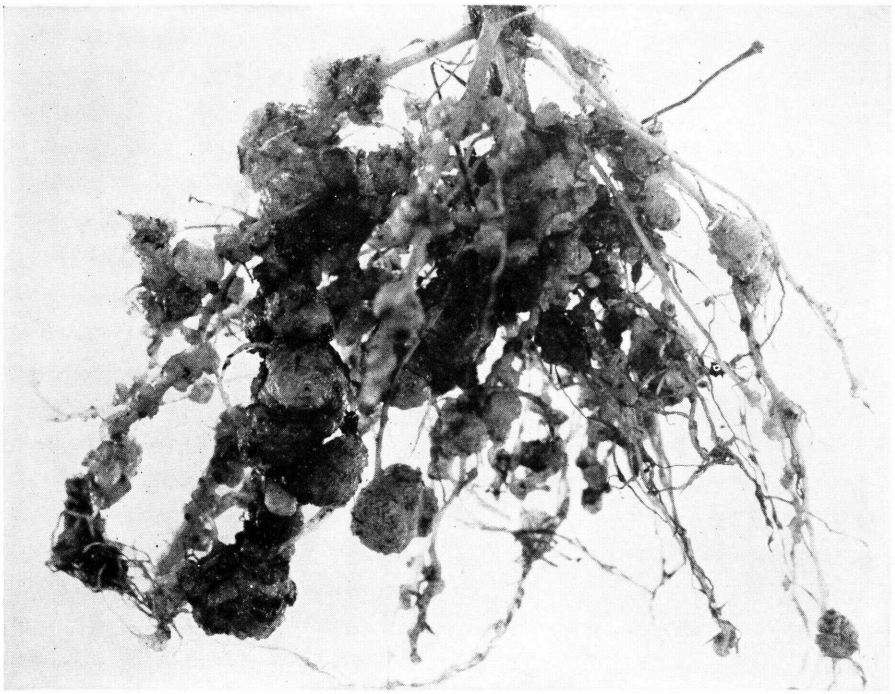

FIGURE 10.—Nematode galls (root knot) on soybean roots.

root, while others are an inch or more in diameter (fig. 10). Nematode galls cannot be removed without breaking the root. By this test, they can be distinguished from the beneficial, nitrogen-forming, bacterial nodules, which are weakly attached to the side of the root and can be broken off easily.

Symptoms on the above ground parts of soybeans that have root knot vary from a slightly lighter color to severe yellowing and marginal firing of the leaves. Slight to severe stunting of the plants occurs. During dry weather, plants with galled roots wilt before normal ones. Severely attacked plants may die a week or more before the normal date of maturity. Seed yields are often greatly reduced by root knot.

Root knot is primarily a problem of the southern soybean-producing areas, and within these areas it is more prevalent on sandy soils. Sometimes, practical control of root knot can be obtained by reducing the nematode population in the soil through growing immune or resistant crops, such as small grains, grasses, or crotalaria, between crops of soybeans. No commercially grown varieties of soybeans are highly resistant to root knot. The varieties Jackson and Lee appear less susceptible than those now commonly grown.

ADAPTATION OF AVAILABLE RESISTANT VARIETIES

The available disease-resistant varieties adapted to the northern, central, and southern soybean-growing regions of the United States are listed in table 1.

TABLE 1.—*Disease-resistant varieties adapted to the major soybean-growing regions of the United States, 1955* [1]

Region	Diseases to which varieties are resistant	Available resistant varieties [2]
Northern (includes Michigan, Minnesota, New York, North Dakota, South Dakota, and Wisconsin).	Bacterial blight	Flambeau and Hawkeye.
	Stem canker	Harosoy.
Central (includes Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Missouri, Nebraska, New Jersey, Ohio, Pennsylvania, and West Virginia).	Bacterial blight	Hawkeye.
	Stem canker	Harosoy.
	Frogeye	Adams, Clark, Lincoln, and Wabash.
	Downy mildew	Chief and Dunfield.
Southern (includes Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Virginia).	Bacterial pustule	Lee and Ogden.
	Wildfire	Lee and Ogden.
	Frogeye	Dorman, Jackson, Lee, and Roanoke.
	Target spot	Jackson, Lee, and Ogden.
	Downy mildew	Acadian and Dorman.
	Purple seed stain	Jackson, Lee, and Roanoke.
	Root knot	Jackson and Lee.

[1] The varieties listed may not be adapted to your particular locality. Consult your State agricultural experiment station for local recommendations.

[2] Varieties differ in their degree of resistance to different diseases. See discussion of specific diseases for further details.

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